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AMENDMENT

(Amendment under the provisions of Article 11 of the law)

To: Mr. Takahiro Inoue, Patent Office Examiner

1. Indication of International Application: PCT/JP2004/006655

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4. Subject of Amendment

Specification and Claims

5. Contents of Amendment

(1) In lines 5-27, page 3 of the specification, amend "the invention …… is." to read "the invention provides an extrusion molding apparatus for a resin tube, comprising a plurality of extruders for thermally melting and extruding resins of different kinds, an inner layer tube molding passage for forwardly passing therethrough the resin extruded from one extruder of these extruders to enable the molding of an inner layer tube, and an outer layer tube molding passage for forwardly passing therethrough the resin extruded from the other extruder to enable the molding of an outer layer tube which is to be externally fitted integrally on said inner layer tube, a die enabling the molding of a multi-layer tube by using these inner and outer layer tubes, said die being formed with inflow passages enabling the resins extruded from said extruders to flow into the rears of said tube molding passages, and flow adjusting valves enabling the respective flows per unit time of the resins flowing through said inflow passages, wherein

each said flow adjusting valve makes openable/closable the communication passage which communicates the intermediate portion of each said inflow passage to outside said die, and each said flow adjusting valve has an opening-degree adjusting valve for adjusting the degree of opening of each said communication passage."

(2) In line 28, page 3 of the specification, delete "another".

(3) In line 2, page 4 of the specification, amend "forwardly from" to read "at".

(4) In line 3, page 4 of the specification, amend "added to another invention" to read "in the invention".

(5) In line11, page 4 to line 6, page 6 of the specification, delete "the invention ····· can be easily effected."

(6) Delete page 5 of the specification, and in line 7, page 6 of the specification, delete "further, another".

(7) In lines 12-16, page 6 of the specification, amend "resin ····· is " to read "said die is formed with inflow passages for enabling the resins extruded from said extruders to flow into the rears of said tube molding passages, and flow adjusting valves are installed which enable the adjustment of the respective flows per unit time of the resins flowing through said inflow passages".

(8) In line 17, page 6 of the specification, amend "With the arrangement thus made" to read "For this reason".

(9) After line 3, page 7 of the specification, add the following sentences:

"Further, each said flow adjusting valve makes openable/closable the communication passage for communicating the intermediate portion of each said inflow passage to outside said die.

For this reason, when said resins are passed from said extruders through the flow adjusting valves and said inflow passages to said tube molding passages, the respective partial flows of the full flows extruded from said extruders are discharged in predetermined amounts by said flow adjusting

valves through said communication passages to outside the die. Thereupon, thereby, the adjustment of the flows of the resins passed to said tube molding passages is made possible.

That is, even in the case where the adjustment of the flow of the resin passed to said tube molding passage is made possible, the full flow extruded from said extruder can be made substantially constant. For this reason, in the case where said tube is to be molded to desired dimensions, trying to change the flow extruded from the extruder would tend to make the control troublesome; however, such control is unnecessary. Consequently, the molding of said accurate tube is facilitated.

Further, each said flow adjusting valve is provided with an opening-degree adjusting valve making adjustable the degree of opening of each said communication passage.

For this reason, partial flow of the resin passing through said communication passage to be discharged to outside the die can be made to have a desired value by the adjustment of the degree of opening of the communication passage by said opening-degree adjusting valve. And, since such adjusting operation can be facilitated, the molding of a tube of desired dimensions is further facilitated."

(10) In line 4, page 7 of the specification, delete "another".

(11) In line 6, page 7 of the specification, amend "forwardly from" to read "at".

(12) In line 23, page 7 of the specification, delete "another".

(13) In lines 4-9, page 10 of the specification, amend "That is, ... molded." to read as follows.

"That is, the extrusion molding apparatus for a resin tube comprises a plurality of extruders for thermally melting and extruding resins of different kinds, an inner layer tube molding passage for forwardly passing therethrough the resin extruded from one extruder of these extruders to enable the molding of an inner layer tube, and an outer layer tube molding passage for forwardly passing therethrough the resin extruded from the

other extruder to enable the molding of an outer layer tube which is to be externally fitted integrally on said inner layer tube, and a die enabling the molding of a multi-layer tube by these inner and outer layer tubes, said die being formed with inflow passages enabling the resins extruded from said extruders to flow into the respective rears of said tube molding passages, flow adjusting valves making adjustable the respective flows per unit time of the resins flowing through said inflow passages, wherein

each said flow adjusting valve makes openable/closable the communication passage for communicating the intermediate portion of each said inflow passage to outside said die, and

each said flow adjusting valve is provided with an opening-degree adjusting valve making adjustable the degree of opening of each said communication passage."

(14) In line 20, page 16 of the specification, amend "extending to" to read "each, which is a portion of each of said inflow passages 21 and 22".

(15) In lines 4 and 5, page 18 of the specification, amend "Further, the above described …… is provided." to read "Further, as described above, each of the flow adjusting valves 34 and 35 is provided with an opening-degree adjusting valve 44 enabling the adjustment of the degree of opening of said communication passage 43."

(16) In line 10, page 18 of the specification, amend "extruded" to read "extruded to flow through said inflow passages 21 and 22".

(17) In line 18, page 18 of the specification, amend "extending to", to read "each, which is a portion of each of said inflow passages 21 and 22"..

(18) In line 4, page 19 of the specification, amend "forwardly from" to read "at".

(19) In line 16, page 19 of the specification, amend "forwardly from" to read "at".

(20) Delete the sentences in [1] -[4] of Claims, page 21.

(21) In line 7, [5] of Claims, page 21, amend "provided"

to reads "provided, said die (11) being formed with inflow passages (21, 22) enabling the resins (3, 4) extruded from said extruders (6, 7) to flow into the respective rears of said tube molding passages (9, 10), flow adjusting valves (34, 35) making adjustable the respective flows per unit time of the resins (3, 4) flowing through said inflow passages (21, 22),".

(22) In lines 9-11, [5] of Claims, pages 21, 22, amend "from said extruders (6, 7) ····· flow adjusting valves (34, 35) are provided" to read "said flow adjusting valves (34, 35) make openable/closable the communication passage (43) for communicating the intermediate portion of said inflow passages (21, 22) to outside said die (11), and

said flow adjusting valves (34, 35) are provided with opening-degree adjusting valves (44) which enable the adjustment of the respective degrees of opening of said communication passages (43)".

(23) In line 3, [6] of Claims, page 22, amend "forwardly from" to read "at".

6. List of Attached Papers

(1) Page 3 of the Specification
(2) Page 4 of the Specification
(3) Page 6 of the Specification
(4) Page 7 and page 7/1 of the Specification
(5) Page 10 and page 10/1 of the Specification
(6) Page 16 and page 16/1 of the Specification
(7) Page 18 of the Specification
(8) Page 19 of the Specification
(9) Page 21 of Claims
(10) Page 22 of Claims

molded by an extrusion molding apparatus.

[0013] Further, another object of the invention is to simplify the arrangement of the extrusion molding apparatus enabling the molding of the accurate tube described above.

[0014] Further, it is also an object to ensure that the molding of the accurate tube described above is easily performed.

[0015] The invention provides an extrusion molding apparatus for a resin tube, comprising a plurality of extruders for thermally melting and extruding resins of different kinds, an inner layer tube molding passage for forwardly passing therethrough the resin extruded from one extruder of these extruders to enable the molding of an inner layer tube, an outer tube molding passage for forwardly passing therethrough the resin extruded from the other extruder to enable the molding of an outer layer tube which is to be externally fitted integrally on said inner layer tube, a die enabling the molding of a multi-layer tube by these inner and outer layer tubes, said die being formed with inflow passages enabling the resins extruded from said extruders to flow into the rears of the said tube molding passages, and flow adjusting valves enabling the adjustment of the respective flows per unit time of the resins flowing through said inflow passages, wherein

[0016] each of said flow adjusting valves makes openable/closable the communication passage for communicating the intermediate portion of said inflow passage to outside said die, and

[0017] each said flow adjusting valve is provided with an opening-degree adjusting valve enabling the adjustment of the degree of opening of said communication passage.

[0018]

[0019]

[0020] Further, in said invention, inner and outer extrusion ports constituting the respective front ends of said

inner and outer layer tube molding passages may be disposed radially close to each other and be opened at the front end surface of the die separately from each other.

[0021] Further, said invention provides an extrusion molding apparatus for a resin tube, with said die formed with a through-hole longitudinally extending through said die and passing inwardly of said inner layer tube molding passage, said tube being externally fitted on a core material forwardly passing through said through-hole, wherein

said inner extrusion port of said inner layer tube molding passage may be disposed radially close to the front end opening constituting the front end of said through-hole.

EFFECTS OF THE INVENTION

[0022] The effects by the invention are as follows.

[0023]

[0024]

[0025]

[0026]

[0034]

[0035]

[0036] The invention provides a plurality of extruders for thermally melting and extruding resins of different kinds, an inner layer tube molding passage for forwardly passing therethrough the resin extruded from one of these extruders to enable the molding of an inner layer tube, and an outer layer tube molding passage for forwardly passing therethrough the resin extruded from the other extruder to enable the molding of an outer layer tube which is to be externally fitted integrally on said inner layer tube, a die enabling the molding of a multi-layer tube by these inner and outer layer tubes, said die being formed with inflow passages enabling the resins extruded from said extruders to flow into the rears of said tube molding passages, and flow adjusting valves respectively enabling the adjustment of each flow per unit time of each resin flowing through the inflow passage.

[0037] For this reason, in the case of molding a multi-layer tube by the driving of each said extruder to cause each resin extruded from each extruder to pass through each said tube molding passage, the flow of said resin can be adjusted by the actuation of each said flow adjusting valve. Consequently, the wall thickness and diameter of said inner and outer layer tubes can be adjusted to respective desired values, providing a desired multi-layer tube.

[0038] Here, the volume of the space in each "passage" for resin flow extending from each said flow adjusting valve to each tube molding passage is smaller than that of such "passage" extending from each extruder to each tube molding passage. For this reason, the volume of the resin filled in each said "passage" becomes also small. Consequently, by the amount corresponding thereto the volumetric variation of said resin due to external force

is suppressed such that it is small.

[0039] And, suppose that each said flow adjusting valve is actuated so as to change the flow of the resin passing from each said flow adjusting valve to each said tube molding passage. In this case, as described above, the volume of the resin in each "passage" is small and volumetric variations due to external force are suppressed such that they are small. For this reason, the change of the flow of the resin passing through each said tube molding passage follows the actuation of each said flow adjusting valve with satisfactory responsiveness. Consequently, the dimensional accuracies of the inner and outer layer tubes of the multi-layer tube being molded by the extrusion molding apparatus can be respectively made further high.

Further, each said flow adjusting valve makes openable/closable the communication passage communicating the intermediate portion of each said inflow passage to outside the die.

For this reason, when said resin is passed from said extruder through the flow adjusting valve and inflow passage to said tube molding passage, a partial flow of the full flow extruded from said extruder is discharged in a predetermined amount to outside the die through said communication passage by said flow adjusting valve. Thereupon, thereby, the adjustment of the flows of the resins passed to said tube molding passages is made possible.

That is, even in the case where the adjustment of the flow of the resin passed to said tube molding passage is made possible, the full flow extruded from said extruder can be made substantially constant. For this reason, in the case where said tube is to be molded to desired dimensions, trying to change the flow extruded from the extruder would tend to make the control troublesome; however, such control is unnecessary.

Consequently, the molding of said accurate tube is facilitated.

Further, each said flow adjusting valve is provided with an opening-degree adjusting valve making adjustable the degree of opening of each said communication passage.

For this reason, partial flow of the resin passing through said communication passage to be discharged to outside the die can be made to have a desired value by the adjustment of the degree of opening of the communication passage by said opening-degree adjusting valve. And, since such adjusting operation can be facilitated, the molding of a tube of desired dimensions is further facilitated.

[0040] Further, in said invention, inner and outer extrusion ports constituting the respective front ends of said inner and outer layer tube molding passages may be disposed radially close to each other and be opened at the front end surface of the die separately from each other.

[0041] With the arrangement thus made, each resin being extruded from each said extruder by the driving of each said extruder is passed through each tube molding passage in said die, thereby molding inner and outer layer tubes. Further, when the inner and outer layer tubes are extruded forwardly of the die from said inner and outer extrusion ports, the outer layer tube is externally fitted on the inner layer tube, thereby molding an integral multi-layer tube.

[0042] In the above case, the inner and outer extrusion ports are disposed radially close to each other. For this reason, when said individual resins pass through the tube molding passages in said die and are forwardly extruded from said inner and outer extrusion ports, said inner and outer layer tubes immediately after being forwardly

extruded from said inner and outer extrusion ports fit together and are smoothly integrated without requiring relatively large radial deformation.

[0043] Furthermore, as described above, the inner and outer extrusion ports are partly or wholly opened forwardly from the front end surface of said die separately from each other. For this reason, when said inner and outer layer tubes fit together, said inner and outer layer tubes are suppressed from pressing each other.

[0044] Consequently, said inner and outer layer tubes are prevented from being unintentionally deformed by mutual pressing. For this reason, the respective wall thicknesses of the inner and outer layers of the multi-layer tube molded by said extrusion molding apparatus can be respectively made more accurate.

[0045] Further, added to said invention, there is provided an extrusion molding apparatus for a resin tube with said die formed with a through-hole longitudinally extending through said die and passing inwardly of said inner layer tube molding passage, said tube being externally fitted on a core material forwardly passing through said through-hole, wherein

said inner extrusion port of said inner layer tube molding passage may be disposed close to the front end opening radially constituting the front end of said through-hole.

[0051] A best mode for carrying out the invention to realize an object which, relating to an extrusion molding apparatus for a resin tube according to the invention, is to make the dimensions of a tube molded by the extrusion molding apparatus more accurate, is as follows.

[0052] That is, the extrusion molding apparatus for a resin tube comprises a plurality of extruders for thermally melting and extruding resins of different kinds, an inner layer tube molding passage for forwardly passing therethrough the resin extruded from one extruder of these extruders to enable the molding of an inner layer tube, and an outer layer tube molding passage for forwardly passing therethrough the resin extruded from the other extruder to enable the molding of an outer layer tube which is to be externally fitted integrally on said inner layer tube, and a die enabling the molding of a multi-layer tube by these inner and outer layer tubes, said die being formed with inflow passages enabling the resins extruded from said extruders to flow into the respective rears of said tube molding passages, flow adjusting valves making adjustable the respective flows per unit time of the resins flowing through said inflow passages, wherein

each said flow adjusting valve makes openable/closable the communication passage communicating the intermediate portion of each said inflow passage to outside the die, and

each said flow adjusting valve is provided with an opening-degree adjusting valve making adjustable each said communication passage.

EMBODIMENTS

[0053] To describe the invention in more detail, embodiments thereof will be described with reference to the accompanying drawings.

[0054] In Figs. 1 - 3, the character 1 denotes an extrusion

molding apparatus. This extrusion molding apparatus 1 is used for extrusion-molding a multi-layer tube 2 of circular section made of resin. This tube 2 comprises an inner layer tube 2a constituting the inner layer thereof, and an outer layer tube 2b constituting the outer layer of said tube 2 and externally fitted on said inner layer tube 2a to be integrally bonded to the outer peripheral surface of this inner layer tube 2a. Said tube 2 is used, e.g., as a material for catheters and its outer diameter is 1.0 - 1.5 mm. Further, the arrow Fr in the figure indicates the forward direction of extrusion of the tube 2 by said extrusion molding apparatus 1.

[0055] The extrusion molding apparatus 1 comprises a plurality (two) of first and second extruders 6 and 7 for thermally melting thermoplastic first and second resins 3 and 4 to enable their extrusion, a die 11 having inner and outer layer tube molding passages 9 and 10 through which the first and second resins 3 and 4 extruded from these first and second extruders 6 and 7 are separately forwardly passed to enable the molding of the inner and outer layer tubes 2a and 2b of said tube 2, a cold-curing device 13 for cold-curing by water said tube 2 molded by being passed through said inner and outer layer tube molding passages 9 and 10, and an electrically driven take-up device 14 for taking up said tube 2 cured by this cold-curing device 13, at a predetermined speed (for example, 2.5 - 10 m/min).

[0056] Said first and second resins 3 and 4 differ from each other in hardness at ordinary temperature. Further, the thermally melting of said first and second resins 3 and 4 is achieved by heater using a heater. Further, said first and second extruders 6

thereby being reduced in radial dimension. Then, this core material 25 is extracted from said tube 2 so as to separate said core material 25 from the inner peripheral surface of the inner layer tube 2a of said tube 2, whereupon said catheter is molded.

[0077] Here, the first resin 3 of which the inner layer tube 2a of said tube 2 is molded differ in hardness from the second resin 4 of which the outer layer tube 2b is molded. For this reason, as shown in Figs. 4 and 5, the inner and outer layer tubes 2a and 2b in the tube 2 have their respective wall thicknesses and radial dimensions radially adjusted. Thereupon, the hardness and shape at any portion longitudinally of said tube 2 can be continuously gradually changed, a fact which is convenient for molding catheters.

[0078] According to the above arrangement, the extrusion molding apparatus 1 comprises extruders 6 and 7 for thermally melting resins 3 and 4 to enable extrusion thereof, and a die 11 having tube molding passages 9 and 10 for forwardly passing therethrough the resins 3 and 4 extruded from the extruders 6 and 7 to make it possible to mold a tube 2, wherein flow adjusting valves 34 and 35 are installed which make it possible to adjust the respective flows per unit time of the resins 3 and 4 passing from said extruders 6 and 7 to the tube molding passages 9 and 10.

[0079] For this reason, in the case of molding the tube 2 by passing the resins 3 and 4, which are extruded from the extruders 6 and 7 by the driving of said extruders 6 and 7, through said tube molding passages 9 and 10, the flows of said resins 3 and 4 are adjusted by the actions attending the operation of said flow adjusting valves 34 and 35. Thereupon, the wall thickness and radial dimension of said tube 2 can be adjusted to desired values, so that a desired tube 2 is obtained.

[0080] Here, the volumes of the spaces in the "passages," which

are portions of said inflow passages 21 and 22 for the flowing of the resins 3 and 4 extending from said flow adjusting valves 34 and 35 to the tube molding passages 9 and 10 is smaller than those extending from the extruders 6 and 7 to the tube molding passages 9 and 10. For this reason, the volumes of the resins 3 and 4 filling said "passages" are also small. Consequently, by an amount corresponding thereto, the volumetric variations of said resins 3 and 4 due to external force are suppressed such that they are small.

[0081] And, suppose that said flow adjusting valves 34 and 35 are actuated so as to change the flows of the resins 3 and 4 passing from said flow adjusting valves 34 and 35 to said tube molding passages 9 and 10. In this case, as described above, the volumes of the resins 3 and 4 in the "passages" are small and volumetric variations due to external force are suppressed such that they are small. For this reason, the changes of the flows of the resins 3 and 4 passing through said tube molding passages

Here, whereas in the case of molding said tube 2 to desired dimensions, trying to change the extrusion flows from the extruders 6 and 7 would tend to make control troublesome, such control is unnecessary. Consequently, the molding of said accurate tube 2 described above is facilitated.

[0089] Further, as described above, the flow adjusting valves 34 and 35 are provided with opening-degree adjusting valves 44 which enable the adjustment of the degrees of opening of said communication passages 43.

[0090] For this reason, the partial flows (Q1) of the resins 3 and 4 discharged to outside the die 11 through said communication passages 43 can adjusted to desired values by the adjustment of the degrees of opening of the communication passages 43 due to said opening-degree adjusting valves 44. And, since such adjusting operation can be easily performed, the molding of the tube 2 of desired dimensions can be further facilitated.

[0091] Further, as described above, there are installed flow adjusting valves 34 and 35 which enable the adjustment of the respective flows per unit time of the resins 3 and 4 extruded from the extruders 6 and 7 to flow through said inflow passages 21 and 22 and passed to said inner and outer layer tube molding passages 9 and 10.

[0092] For this reason, in the case of molding a multi-layer tube 2 by the driving of said extruders 6 and 7 to cause resins 3 and 4 extruded from the extruders 6 and 7 to pass through said tube molding passages 9 and 10, the flows of said resins 3 and 4 can be adjusted by the actions attending the operation on said flow adjusting valves 34 and 35. Consequently, the wall thicknesses and radial dimensions of said inner and outer layer tubes 2a and 2b can be adjusted to respective desired values, providing a desired multi-layer tube 2.

[0093] Here, the volumes of the spaces in the "passages," which are portions of said inflow passages 21 and 22 for the

flowing of the resins 3 and 4 extending from said flow adjusting valves 34 and 35 to the tube molding passages 9 and 10 are smaller than those extending from the extruders 6 and 7 to the tube molding passages 9 and 10. For this reason, the volumes of the resins 3 and 4 filled in said "passages" become also small. Consequently, by the amount corresponding thereto the volumetric variations of said resins 3 and 4 due to external force are suppressed such that they are small.

[0094] And, suppose that said flow adjusting valves 34 and 35 are actuated so as to change the flows of the resins 3 and 4 passing from said flow adjusting valves 34 and 35 to said tube molding passages 9 and 10. In this case, as described above, the volumes of the resins 3 and 4 in the "passages" are small and volumetric variations due to external force are suppressed such that they are small. For this reason, the changes of the flows of the resins 3 and 4 passing through said tube molding passages 9 and 10 follow the actuation of said flow adjusting valves 34 and 35 with satisfactory responsiveness. Consequently, the dimensional accuracies of the inner and outer layer tubes 2a and 2b of the multi-layer tube 2 being molded by the extrusion molding apparatus 1 can be respectively made further high.

[0095] Further, as described above, the inner and outer extrusion ports 17 and 18 constituting the respective front ends of the inner and outer tube molding passages 9 and 10 are disposed close to each other radially of said axis 16, and are opened at the front end surface 19 of the die 11 separately from each other.

[0096] For this reason, the resins 3 and 4 extruded from these extruders 6 and 7 by the driving of the extruders 6 and 7 are passed through the tube molding passages 9 and 10 of said die 11, thereby molding the inner and outer layer tubes 2a and 2b. Further, when the inner and outer layer tubes 2a and 2b, which are extruded from said inner and

outer extrusion ports 17 and 18, forwardly of the die 11, the outer layer tube 2b is externally fitted integrally on said inner layer tube 2a, so that a multi-layer tube 2 is molded.

[0097] In the above case, the inner and outer extrusion ports 17 and 18 are disposed radially close to each other. For this reason, when said resins 3 and 4 are passed through the tube molding passages 9 and 10 of said die 11 and extruded forwardly from the inner and outer extrusion ports 17 and 18, said inner and outer layer tubes 2a and 2b immediately after they are forwardly extruded from said inner and outer extrusion ports 17 and 18 fit together without requiring relatively large radial deformation, and smoothly integrated.

[0098] Furthermore, as described above, the inner and outer extrusion ports 17 and 18 are partly or wholly opened at the front end surface 19 of said die 11 separately from each other. For this reason, when said inner and outer layer tubes 2a and 2b fit together, these inner and outer layer tubes 2a and 2b are suppressed from pressing each other.

[0099] Consequently, said inner and outer layer tubes 2a and 2b are prevented from being unintentionally deformed by mutual pressing. For this reason, the respective wall thicknesses of the inner and outer layers of the multi-layer tube 2 molded by said extrusion molding apparatus 1 can be respectively made more accurate.

[0100] Further, said inner and outer extrusion ports 17 and 18 extend along said axis 16 and substantially in parallel with each other.

[0101] For this reason, when said inner and outer layer tubes 2a and 2b immediately after they are forwardly extruded from said inner and outer extrusion ports 17 and 18 fit together, these inner and outer layer tubes 2a and 2b are more reliably suppressed from pressing each other. Consequently, said inner and outer layer tubes are

prevented from being unintentionally deformed by mutual pressing. As a result, the respective wall thicknesses of said inner and outer layer tubes 2a and 2b can be made further accurate.